

WL-TR-95-3008

CONNECTED SPEECH STUDY FOR
COCKPIT APPLICATIONS

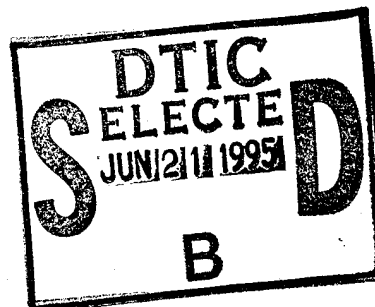


TIMOTHY P. BARRY
1LT. THOMAS J. SOLZ
DR. JOHN M. REISING

PILOT VEHICLE INTERFACE TECHNOLOGY SECTION
ADVANCED COCKPIT BRANCH
FLIGHT CONTROL DIVISION

FEBRUARY 1994

INTERIM REPORT FOR 09/21/93 - 11/01/93



APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

FLIGHT DYNAMICS DIRECTORATE
WRIGHT LABORATORY
AIR FORCE MATERIEL COMMAND
WRIGHT PATTERSON AFB OH 45433-7562

DTIC QUALITY INSPECTED 3

19950619 027

NOTICE

WHEN GOVERNMENT DRAWINGS, SPECIFICATIONS, OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A DEFINITELY GOVERNMENT-RELATED PROCUREMENT, THE UNITED STATES GOVERNMENT INCURS NO RESPONSIBILITY OR ANY OBLIGATION WHATSOEVER. THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED OR IN ANY WAY SUPPLIED THE SAID DRAWINGS, SPECIFICATIONS, OR OTHER DATA, IS NOT TO BE REGARDED BY IMPLICATION, OR OTHERWISE IN ANY MANNER CONSTRUED, AS LICENSING THE HOLDER, OR ANY OTHER PERSON OR CORPORATION; OR AS CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE, OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED HERETO.

THIS TECHNICAL REPORT HAS BEEN REVIEWED AND APPROVED FOR PUBLICATION.



THOMAS J. SOLZ, JR., 1LT, USAF
HUMAN FACTORS ENGINEER
PILOT/VEHICLE INTERFACE
TECHNOLOGY SECTION



PETER G. RAETH, MAJOR, USAF
CHIEF, PILOT/VEHICLE INTERFACE
TECHNOLOGY SECTION
WRIGHT LABORATORY



JOSEPH C. VON HOLLE, LT COL, USAF
CHIEF, ADVANCED COCKPIT TECHNOLOGY INTEGRATED PRODUCT TEAM
WRIGHT LABORATORY

IF YOUR ADDRESS HAS CHANGED, IF YOU WISH TO BE REMOVED FROM OUR MAILING LIST, OR IF THE ADDRESSEE IS NO LONGER EMPLOYED BY YOUR ORGANIZATION PLEASE NOTIFY WL/FIP, WRIGHT-PATTERSON AFB, OH 45433-7511 TO HELP MAINTAIN A CURRENT MAILING LIST.

COPIES OF THIS REPORT SHOULD NOT BE RETURNED UNLESS RETURN IS REQUIRED BY SECURITY CONSIDERATIONS, CONTRACTUAL OBLIGATIONS, OR NOTICE ON A SPECIFIC DOCUMENT.

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE February 1994		3. REPORT TYPE AND DATES COVERED Technical Report 09-21-93 to 11-01-93
4. TITLE AND SUBTITLE Connected Speech Study for Cockpit Applications			5. FUNDING NUMBERS PE: 62201F PR: 2403 TA: 04 WU: 86	
6. AUTHOR(S) Timothy P. Barry 1Lt Thomas J. Solz, Jr. Dr. John M. Reising				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Advanced Cockpit Branch WL/FIGP Bldg 146 2210 Eighth Street Ste 1 Wright-Patterson AFB OH 45433-7511			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Flight Dynamics Directorate Wright Laboratory Air Force Materiel Command Wright-Patterson AFB, OH 45433-7562			10. SPONSORING/MONITORING AGENCY REPORT NUMBER WL-TR-95-3008	
11. SUPPLEMENTARY NOTES None				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) Eleven subjects participated in a study designed to test the accuracy of a newer generation connected speech recognition system using 49 vocabulary words likely to be tested in an aircraft cockpit environment. The 49 vocabulary words were used to create 392 phrases. These phrases were divided into three groups: COMPLEX phrases, which contained more than five words, and two groups of SIMPLE phrases, which contained 5 words or less. The simple phrases were divided into SIMPLE ALTERNATE and SIMPLE NO-ALTERNATE phrases depending on whether or not the phrase was the only one in the entire vocabulary capable of carrying out a particular action once recognition occurred. Performance of the recognition system was measured with three accuracy statistics: WORD ACCURACY, which is most commonly reported in speech recognition research, PHRASE ACCURACY, which is gaining popularity in connected speech recognition research, and INTENT ACCURACY, which is probably the most relevant statistic that could be reported in research of this type. Significantly different word, phrase, and intent accuracy results were obtained for the three different phrase types.				
14. SUBJECT TERMS speech recognition, connected speech, recognition accuracy			15. NUMBER OF PAGES 40	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL	

Table of Contents

1. INTRODUCTION	1
2. METHOD	3
2.1 Objectives	3
2.2 Subjects	3
2.3 Materials	3
2.3.1 Phrase Complexity	3
2.3.2 Number of Alternatives	4
2.4 Hardware	4
2.5 Software	5
2.6 Experimental Design	5
2.7 Dependent Measures	6
2.8 Data Analyses	7
2.9 Procedures	8
3. RESULTS	10
3.1 Word Accuracy	10
3.2 Phrase Accuracy	11
3.3 Intent Accuracy	11
4. DISCUSSION	14
APPENDIX A. VOCABULARY WORD LIST	16
APPENDIX B. VOCABULARY STRUCTURE	17
APPENDIX C. LIST OF 392 TEST PHRASES	18
APPENDIX D. SUBJECT BRIEFING	23
APPENDIX E. SUMMARY DATA	24

Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

LIST OF TABLES

TABLE 1. DISTRIBUTION OF PHRASE TYPES USED IN EACH TRIAL	4
TABLE 2. SEEDS USED TO RANDOMIZE PHRASES	6
TABLE 3. DATA MATRIX	6
TABLE 4. PRELIMINARY ANOVA SUMMARY TABLE	8
TABLE 5. EXPERIMENT TIME LINE	9
TABLE 6. ANOVA SUMMARY TABLE FOR WORD ACCURACY	10
TABLE 7. ANOVA SUMMARY TABLE FOR PHRASE ACCURACY	12
TABLE 8. ANOVA SUMMARY TABLE FOR INTENT ACCURACY	13

LIST OF FIGURES

FIGURE 1. 3 X 3 X 2 FACTORIAL WITHIN SUBJECTS EXPERIMENTAL DESIGN	8
FIGURE 2. WORD ACCURACY COMPARISONS FOR PHRASE TYPE	11
FIGURE 3. PHRASE ACCURACY COMPARISONS FOR PHRASE TYPE	12
FIGURE 4. INTENT ACCURACY COMPARISONS FOR PHRASE TYPE	13

1. INTRODUCTION

The potential use of automated speech recognition technology as a natural, alternative method for the management of aircraft subsystems has been studied by the Air Force for over 10 years, but because recognition accuracies have not attained acceptable levels for use in the cockpit, this technology has not yet become operational in that environment. Recent work in the area of "parallel recognition" in addition to natural advances in computational speed and signal processing techniques have resulted in significant increases in recognition accuracies, spawning a renewed interest in the application of this technology to the pilot-vehicle interface paradigm.

Speech recognition has long been advocated as a natural and intuitive method by which humans could potentially communicate with complex systems. One such system is the modern fighter aircraft. As more sophisticated avionics are incorporated, the challenge of managing all the various information sources becomes very critical. From on and off-board sensor manipulation to weapons, communications and navigation control, the single seat fighter pilot has limited ability to effectively manage all of the various information available using just hands and eyes. For these reasons, researchers have been exploring the possibilities of using speech recognition technology to augment the pilot's ability to control and display information in the cockpit (Lizza and Goulet, 1986; Williamson and Barry, 1990).

The majority of speech recognition research in the laboratory and flight test environments has centered around the use of **discrete** word recognition systems, which require short pauses between each word in the phrase. Natural advances in computational speed and signal processing techniques have resulted in significant increases in the **word** recognition accuracies of these devices, which recognize the single words or utterances. Additional work in the area of "parallel recognition" has further demonstrated the promise of this discrete word recognition technology to facilitate simple communication between the pilot and the computers which control the myriad of subsystems aboard the aircraft (Barry, Liggett, Williamson and Reising, 1992; Barry, Solz, Reising and Williamson, 1994).

More recent work has focused on newer-generation **connected** speech recognition systems, which do not require artificial pauses to be placed between the words in a phrase. These systems show tremendous potential for providing the pilot with the ability to use longer and more complicated sentences when communicating with the aircraft, while yielding **phrase** accuracies above 95%. Current research efforts are focused on allowing the pilot more word and phrase flexibility when using this connected speech recognition technology. With the multiple options all representing one single pilot intention however, **intent** accuracy becomes meaningful. The eventual payoff of this research will be the attainment of the ultimate pilot-vehicle interface research goal: a natural-language interface between the pilot and his/her aircraft.

This report describes the results of a laboratory test conducted to determine the word and phrase accuracy of a connected speech recognition device and to investigate the use of alternate syntax phrases to yield increased intent accuracy.

2. METHOD

2.1 Objectives

The objective of this study was to determine the connected speech recognition accuracy of the ITT-1290 Speech Recognition System using a vocabulary structure containing relatively "simple" and "complex" phrases.

2.2 Subjects

Eleven subjects from the Cockpit Integration Division took part in the study. Since previous research in the speech recognition area revealed no significant gender differences in recognition accuracy, the subject pool consisted of both male and female participants. No tests for gender differences were planned.

2.3 Materials

The vocabulary used to test the recognition accuracy of the ITT-1290 system consisted of 49 words that are likely to be used in the cockpit environment. The 49 word vocabulary can be found in Appendix A. These words were combined to create a total of 392 stimulus phrases that were presented to the subjects for recognition. The manner in which these words were combined defined the vocabulary phrase structure. Appendix B. presents the vocabulary phrase structure for this study.

Two different factors were considered in the creation of the test phrases. These two factors were COMPLEXITY and NUMBER OF ALTERNATES.

2.3.1 Phrase Complexity

Phrase Complexity defined the number of individual vocabulary words that made up the phrase. Of the 392 stimulus phrases, half (196) of them were SIMPLE phrases and the other half were COMPLEX phrases. For this study, Simple phrases were defined as those phrases that contained less than 5 vocabulary words, while Complex phrases contained 5 or more vocabulary words. For example, the phrase

"change waypoint eight"

was a Simple phrase because it contained less than 5 vocabulary words. The phrase

"north three four seven six point one two"

was a Complex phrase because it contained 5 or more vocabulary words.

2.3.2 Number of Alternates

In an aircraft cockpit application, the recognition of a spoken phrase would result in some action being taken by the aircraft. For example, recognition of the phrase

"configure for landing"

would result in the computer sending the appropriate command to the aircraft to change its configuration in preparation for landing. There were other phrases in the phrase set that also would result in the identical command being sent to the aircraft when recognized. The phrase

"setup landing"

also would result in the aircraft changing its configuration in preparation for landing. These two phrases were said to be ALTERNATE phrases. Of the 392 phrases in the study, 147 phrases were Alternate phrases - those having at least one other alternate in the phrase set. The remaining 245 phrases had no alternates (i.e. no other phrase in the set could produce an identical aircraft action.)

Table 1 summarizes the make-up of the 392 stimulus phrases that were presented to the subjects in the this study. Of the 196 **Simple** phrases, 147 had Alternates, while the remaining 49 had no Alternates. None of the 196 **Complex** phrases had Alternates.

Table 1. Distribution of Phrase Types Used in Each Trial

		Phrase Complexity		
		Simple	Complex	Total Phrases
Number of Alternates	At least One Alternate	147	0	147
	No Alternates	49	196	245
	Total Phrases	196	196	392

Appendix C contains a complete list of the 392 phrases used in this study.

2.4 Hardware

The ITT-1290 speech recognition system was hosted in a Gateway 2000 4DX2-50V computer system. A Plantronics SNC1657-01 microphone was used for speech input. The host computer monitor was used to present stimulus phrases to the subject for

The ITT-1290 speech recognition system was hosted in a Gateway 2000 4DX2-50V computer system. A Plantronics SNC1657-01 microphone was used for speech input. The host computer monitor was used to present stimulus phrases to the subject for recognition. Recognition results were presented on the computer monitor and also stored in a data file on disk.

2.5 Software

The ITT TGS program supplied with the speech recognition hardware was used to train the subjects. The following custom software programs written specifically for this experiment were also used:

<u>Program Name</u>	<u>Program Description</u>
COMPLEXP.EXE	Randomly generated complex phrases based on latitude / longitude digit strings
ITT_CONN.EXE	Presented phrases to be spoken and stored results on disk.
RANDOM.EXE	Generated random seeds used by the RANDSORT program.
RANDSORT.EXE	Read phrases from a file and wrote them back to disk in random order.
SCORE_CO.EXE	Read the raw data produced by the ITT_CONN program, scored the data, and created a summary data file used by SPSS for data analysis.

2.6 Experimental Design

The experimental design was a 3 x 3 x 2 complete factorial Within Subjects design with three levels of Phrase Type (Simple Alternate, Simple No-Alternate, Complex No-Alternate), three Presentation Sets, and two separate Trials. Program RANDSORT used the seeds in Table 2 to randomly re-order the 392 phrases presented to each subject per Trial.

After the phrases were re-ordered, they were grouped into 3 sets (Set 1 contained 131 phrases, Set 2 contained 131, and Set 3 contained 130). In Trial 1, the subjects were presented with the phrases in Set 1, then Set 2, then Set 3, while in Trial 2, the phrases in Set 3 were presented first, followed by the phrases in Set 2 and then Set 1. The two data collection trials were run approximately 10 days apart. The data matrix is shown in Table 3.

Table 2. Seeds Used to Randomize Phrases

Subject Number	Random Seed used by RANDSORT program
1	11357
2	12014
3	20865
4	22513
5	22940
6	17563
7	1171
8	10731
9	26229
10	57384
11	56833

Table 3. Data Matrix

S u b	Trial 1									Trial 2								
	Set 1			Set 2			Set 3			Set 1			Set 2			Set 3		
	S A	S N	C N	S A	S N	C N	S A	S N	C N	S A	S N	C N	S A	S N	C N	S A	S N	C N
1	131 Phrases			131 Phrases			130 Phrases			131 Phrases			131 Phrases			130 Phrases		
....		
11	131 Phrases			131 Phrases			130 Phrases			131 Phrases			131 Phrases			130 Phrases		
Tot	1441 Phrases			1441 Phrases			1430 Phrases			1441 Phrases			1441 Phrases			1430 Phrases		
	4312 Phrases									4312 Phrases								

2.7 Dependent Measures

Three speech recognition accuracy values were computed for this study. They were:

Word Accuracy	=	Total words correct / Total words presented
Phrase Accuracy	=	Total phrases correct / Total phrases presented
Intent Accuracy	=	Total resulting actions correct / Total actions presented

To further explain the meaning of these three dependent measures, consider the following example:

Phrase presented:	Configure	for	Takeoff
Phrase recognized:	Setup		Takeoff

A total of 3 words were presented, with only the word "Takeoff" being correctly recognized. Word accuracy for this phrase was therefore $1 / 3 = 33$ percent.

Word Accuracy = $1 / 3 = 33$ percent

One phrase was presented, but the wrong phrase was recognized. Phrase accuracy is therefore $0 / 1 = 0$ percent.

Phrase Accuracy = $0 / 1 = 0$ percent

Even though the wrong phrase was recognized, the resulting action in the cockpit would still have been the same as if the correct phrase had been recognized, that being a reconfiguration of the aircraft to prepare for takeoff. Intent accuracy therefore is $1 / 1 = 100$ percent.

Intent Accuracy = $1 / 1 = 100$ percent

The use of intent accuracy is actually only meaningful for Alternate phrases which, as described in a previous section, were those phrases that provided an alternative method for accomplishing the same action. The phrases "configure for takeoff" and "setup takeoff" both resulted in the same action and were therefore candidates for Intent Accuracy analysis. In the case of the phrase "select Maverick", there was no other phrase in the entire syntax that could result in a selection of the Maverick missile. In these cases, Intent Accuracy and Phrase Accuracy were identical. Of the 392 phrases presented in each trial, only the 147 Alternate phrases were used in the computation of Intent Accuracy.

2.8 Data Analyses

The $3 \times 3 \times 2$ factorial Within Subjects experimental design is represented in Figure 1. The numbers in parentheses are the Degrees of Freedom (DF) for each effect. From the proposed experimental design, the Preliminary ANOVA Summary Table can be derived and is presented in Table 4.

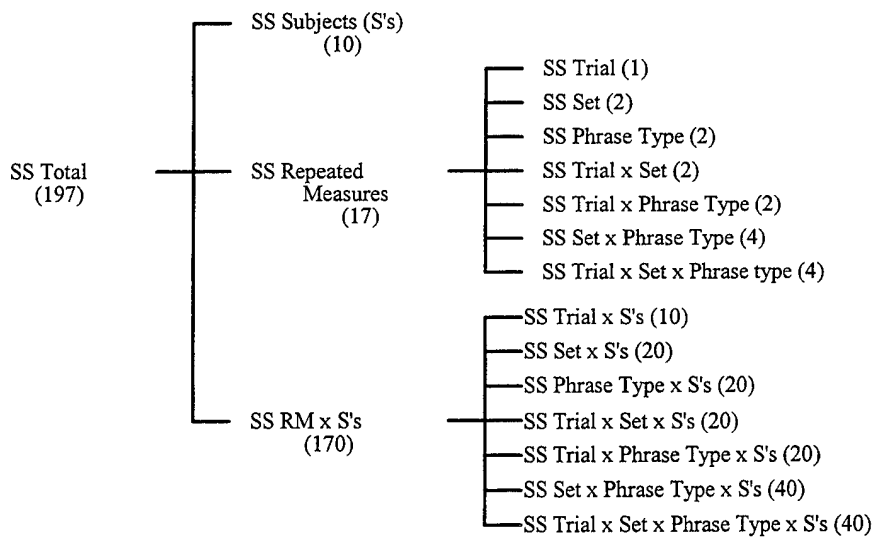


Figure 1. 3 x 3 x 2 Factorial Within Subjects Experimental Design

Table 4. Preliminary ANOVA Summary Table

<u>Source</u>	<u>DF</u> <u>S</u>	<u>Error Term</u>	<u>DFE</u> <u>T</u>	<u>Fcrit</u> <u>(.05)</u>
Trial	1	Trial x S's	10	4.96
Set	2	Set x S's	20	3.49
Phrase Type	2	Phrase Type x S's	20	3.49
Trial x Set	2	Trial x Set x S's	20	3.49
Trial x Phrase Type	2	Trial x Phrase Type x S's	20	3.49
Set x Phrase Type	4	Set x Phrase Type x S's	40	2.61
Trial x Set x Phrase Type	4	Trial x Set x Phrase Type x S's	40	2.61

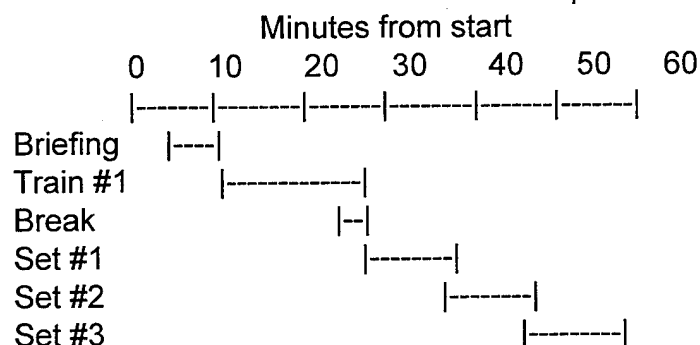
2.9 Procedures

The first experimental session (Trial 1) for each subject was scheduled to last for approximately 60 minutes. The tasks accomplished during this period are shown in Table 5.

For the first 5 minutes, subjects were briefed on the nature of the experiment. Appendix D presents the subject briefing. Subjects were shown the experimental setup and were given a brief explanation of how speech recognition works. Any questions were answered. Following the initial briefing, the subjects "trained" the speech system to collect the speech templates for use in the recognition portion of the experiment. During training, the subjects received some practice in recognition while the

experimenter tested the validity of the templates. The subjects were given a short break following the template training session.

Table 5. Experiment Time Line



During the data collection session, the phrases contained in the first set were presented, one at a time, on the computer screen in front of the subject. The subjects' task was to simply say the phrase. The ITT-1290 speech recognition system received the speech signal and attempted recognition of each word in the phrase. If the subject made a mistake in reading the prompted phrase, the phrase was simply presented again. When all phrases within a set were presented, the subject was given a 1- or 2-minute break while the experimenter reconfigured the system in preparation for the presentation of the next set of phrases.

Data collection for Trial 2 occurred approximately 10 days after the subject completed Trial 1. The data collection procedures used in Trial 1 were again used in Trial 2, with the exception that the speech recognition system was not retrained. The recognition templates generated in preparation for Trial 1 were used during recognition in Trial 2.

3. RESULTS

Recognition data for both Trials were collected for all 11 subjects over a three week period of time. Program SCORE_CO, written specifically for this study, was used to score the raw data and to generate summary statistics that could be analyzed using the SPSS software. Appendix E contains the summary data generated by the program for each subject, along with a one-page table summarizing the overall results of the test.

SPSS program analyses were done to test the experimental effects of Trial, Set order, and Phrase Type on the 3 dependent measures of Word Accuracy, Phrase Accuracy, and Intent Accuracy.

3.1 Word Accuracy

The results of the Analysis of Variance for Word Accuracy, summarized in Table 6, revealed a significant main effect for Phrase Type ($F = 19.03$, $p < 0.000$). That is, different word accuracies were obtained by the Alternate, No Alternate and Complex phrases. Orthogonal, pairwise comparisons of the Phrase Type revealed significantly better word recognition accuracies for Complex phrases than for Alternate phrases ($F = 21.78$, $p < 0.001$) and better accuracies for No Alternate phrases compared with Alternate phrases ($F = 24.65$, $p < 0.001$), as shown in Figure 2. No other significant effects were observed.

Table 6. ANOVA Summary Table for Word Accuracy

<u>Source</u>	<u>SS</u>	<u>DF</u>	<u>MS</u>	<u>F</u>	<u>Sig. of F</u>
Trial	0.24	1	0.24	0.22	$p < 0.649$
Set	0.87	2	0.43	0.54	$p < 0.588$
Phrase Type	167.55	2	83.77	19.03	$p < 0.000^{***}$
Trial x Set	1.63	2	0.82	1.09	$p < 0.355$
Trial x Phrase Type	4.06	2	2.03	1.73	$p < 0.203$
Set x Phrase Type	0.61	4	0.15	0.20	$p < 0.936$
Trial x Set x Phrase Type	5.10	4	1.28	1.35	$p < 0.267$
Complex vs No Alternate comparison	0.12	1	0.12	0.24	$p < 0.632$
Complex vs Alternate comparison	18.97	1	18.97	21.78	$p < 0.001^{***}$
No Alternate vs Alternate comparison	22.10	1	22.10	24.65	$p < 0.001^{***}$

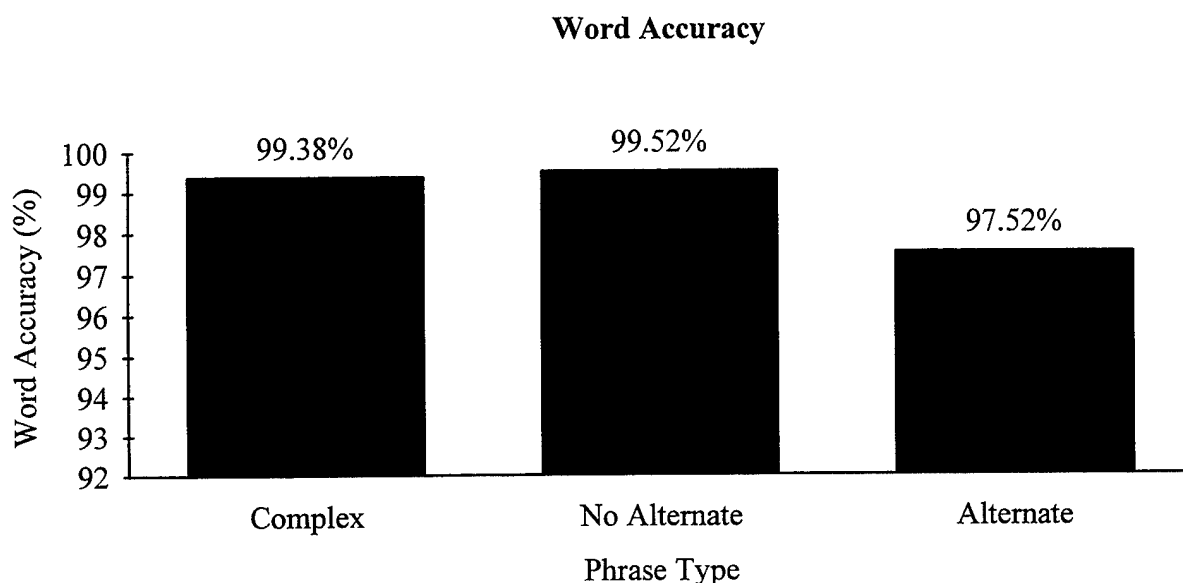


Figure 2. Word Accuracy Comparisons for Phrase Type

3.2 Phrase Accuracy

The results of the Analysis of Variance for Phrase Accuracy are summarized in Table 7. A significant main effect for Phrase Type ($F = 15.46$, $p < 0.000$) was observed, indicating that different phrase accuracies were obtained by the Alternate, No Alternate and Complex phrases. Orthogonal, pairwise comparisons of the Phrase Type revealed significantly better phrase recognition accuracies for No Alternate phrases than for Complex phrases ($F = 11.12$, $p < 0.008$) and better accuracies for No Alternate phrases compared with Alternate phrases ($F = 34.18$, $p < 0.000$), as shown in Figure 3. No other significant effects were observed.

3.3 Intent Accuracy

Table 8 shows the results of the Analysis of Variance for Intent Accuracy. A significant main effect for Phrase Type ($F = 9.75$, $p < 0.001$) was observed, indicating that different intent accuracies were obtained by the Alternate, No Alternate and Complex phrases. Orthogonal, pairwise comparisons of the Phrase Type revealed significantly better intent recognition accuracies for No Alternate phrases than for Complex phrases ($F = 11.12$, $p < 0.008$) and better accuracies for Alternate phrases compared with Complex phrases ($F = 12.13$, $p < 0.006$), as shown in Figure 4. No other significant effects were observed.

Table 7. ANOVA Summary Table for Phrase Accuracy

<u>Source</u>	<u>SS</u>	<u>DF</u>	<u>MS</u>	<u>F</u>	<u>Sig of F</u>
Trial	0.03	1	0.03	0.00	p < 0.964
Set	10.71	2	5.35	0.70	p < 0.509
Phrase Type	916.82	2	458.41	15.46	p < 0.000***
Trial x Set	6.68	2	3.34	0.62	P < 0.547
Trial x Phrase Type	23.59	2	11.79	1.44	p < 0.260
Set x Phrase Type	9.99	4	2.50	0.37	p < 0.831
Trial x Set x Phrase Type	38.60	4	9.65	0.75	p < 0.567
Complex vs No Alternate comparison	63.92	1	63.92	11.12	p < 0.008***
Complex vs Alternate comparison	16.34	1	16.34	3.16	p < 0.106
No Alternate vs Alternate comparison	114.91	1	114.91	34.18	p < 0.000***

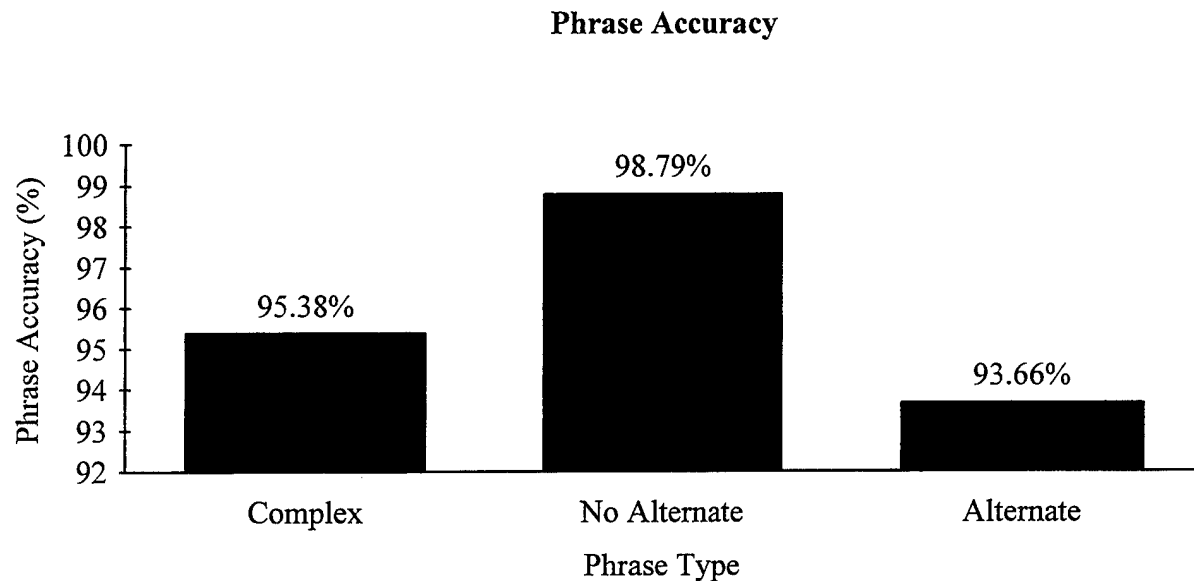


Figure 3. Phrase Accuracy Comparisons for Phrase Type

Table 8. ANOVA Summary Table for Intent Accuracy

<u>Source</u>	<u>SS</u>	<u>DF</u>	<u>MS</u>	<u>F</u>	<u>Sig of F</u>
Trial	0.64	1	0.64	0.07	p < 0.791
Set	9.16	2	4.58	0.88	p < 0.430
Phrase Type	545.83	2	272.92	9.75	p < 0.001***
Trial x Set	7.16	2	3.58	0.63	p < 0.541
Trial x Phrase Type	18.35	2	9.17	1.24	p < 0.311
Set x Phrase Type	8.67	4	2.17	0.43	p < 0.788
Trial x Set x Phrase Type	23.73	4	5.93	0.79	p < 0.537
Complex vs No Alternate comparison	63.92	1	63.92	11.12	p < 0.008***
Complex vs Alternate comparison	72.30	1	72.30	12.13	p < 0.006***
No Alternate vs Alternate comparison	0.26	1	0.26	0.10	p < 0.755

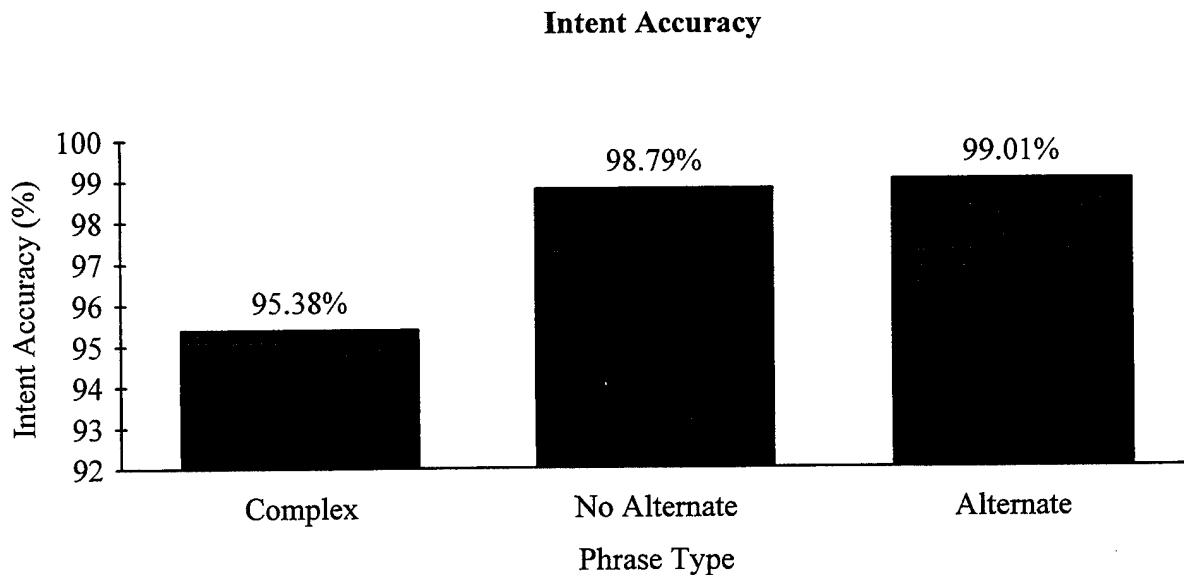


Figure 4. Intent Accuracy Comparisons for Phrase Type

4. DISCUSSION

The test of the ITT-1290 speech recognition system resulted in the collection of data for 8,600 phrase utterances and over 48,000 word utterances by the 11 subjects. When summarizing the data for all phrases regardless of phrase complexity and number of alternates, overall **phrase accuracy** was slightly over 95%. That is, 95% of the phrases had every single word in the phrase recognized correctly. When phrase intent was taken into account, **intent accuracy** climbed to over 97%. This means that the recognized phrase would have resulted in the correct action being taken in the cockpit, not 95% of the time, but actually 97% of the time. Individual **word accuracy**, the statistic with which most speech recognition researchers are familiar, was over 99%.

In any speech recognition test such as this, the accuracy of the system must be viewed in light of the specific word vocabulary and phrase structure being implemented. The majority of work required to create a workable vocabulary involves selecting words and phrases that are not easily confused by the speech recognition system, while at the same time, allowing the user (pilot) ample flexibility to use a natural language with multiple phrases that accomplish the same action. Allowing flexibility in a complex digit entry task, on one hand, is very difficult to do. In this study, there were no synonyms for the digit words zero through nine. This was the reason that phrase accuracy and intent accuracy were identical for all complex phrases. The same held true for the Simple phrases that had no alternates (Simple No-Alternate phrases). The Simple Alternate phrases on the other hand are, by definition, loaded with flexibility.

Alternate phrases were created to provide the pilot with multiple speech options in accomplishing the task. The pilot could, for example, request a cockpit format by using a phrase that started with either "show" or "show-me." Different phrases utilizing optional words like "the," "thee," and "for" could also be spoken. For Alternate phrases, phrase accuracy and intent accuracy took on a special meaning. The phrase accuracy for the set of Alternate phrases was only 93.66%. The word pairs "show" and "show-me" and "the" and "thee" were the cause of most of the substitution errors that contributed to the relatively low accuracy statistic. Other small vocabulary words like "my" and "for" accounted for the most number of rejection errors. When intent accuracy was computed for these phrases however, intent accuracy was found to be 99.01%, an increase of over 5%. If the recognition system failed to hear the word "my" in the phrase "show my hydraulics," the recognized phrase still would have resulted in the aircraft displaying a hydraulic format in the cockpit. Intent accuracy only suffered when the substitution involved a word that was important to the phrase's intent.

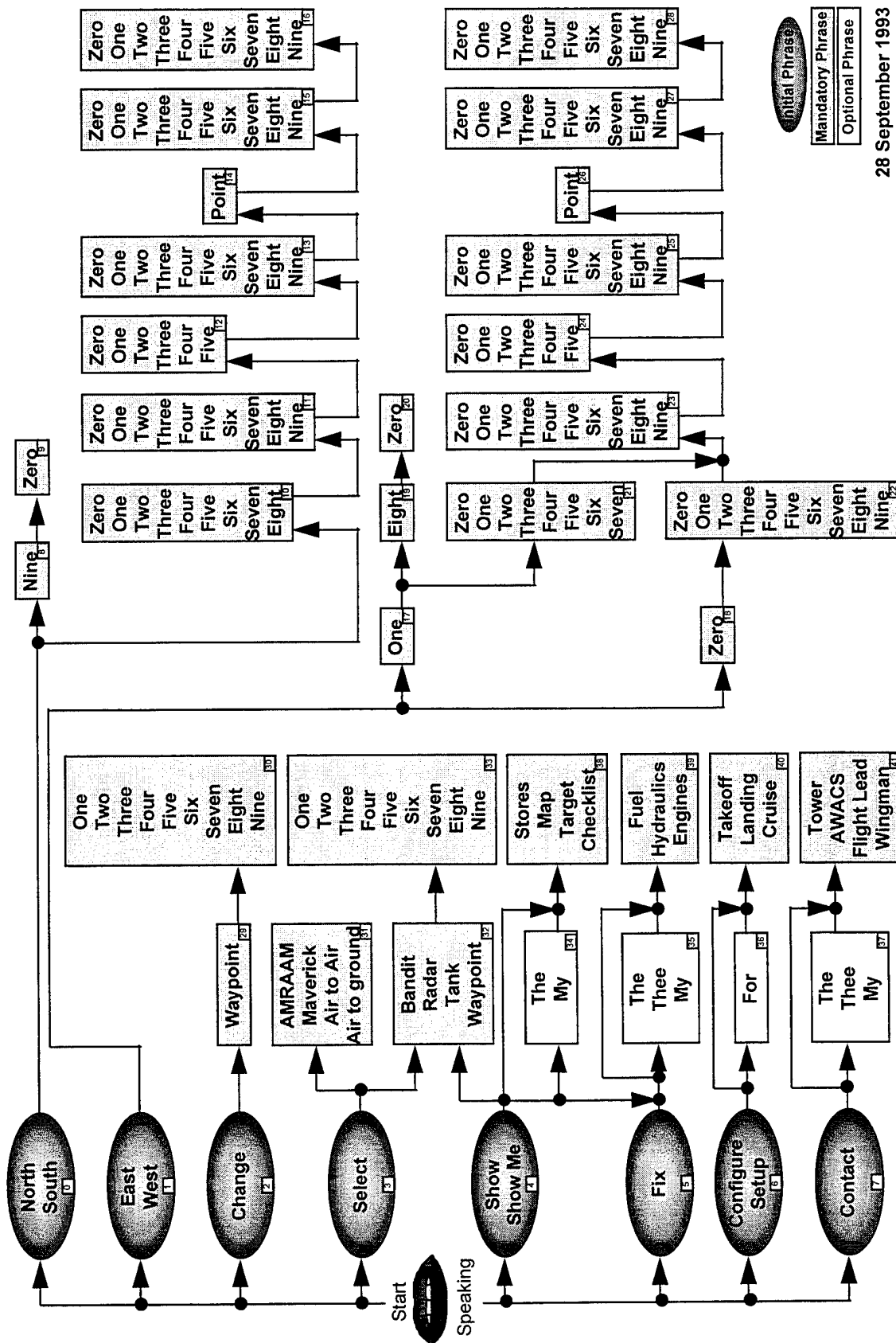
Given the size and complexity of the vocabulary structure used in this test, the ITT-1290 recognition system performed admirably, and should continue to perform well in most PVI related simulation efforts involving speech recognition tasks. The only negative aspect noted by the subjects in the use of this system was the amount of

template training required to attain good performance. Three subjects also expressed minor concern when the "TGS" training software quit operating in the middle of the training session, threatening the loss of templates generated up to that time. The issue of template training time and the minor problems with the training software should be addressed in future work with this system.

Appendix A. Vocabulary Word List

<u>Word Number</u>	<u>Word Text</u>	<u>Word Number</u>	<u>Word Text</u>
1.	air-to-air	26.	north
2.	air-to-ground	27.	one
3.	AMRAAM	28.	point
4.	AWACS	29.	radar
5.	bandit	30.	select
6.	change	31.	setup
7.	checklist	32.	seven
8.	configure	33.	show
9.	contact	34.	show-me
10.	cruise	35.	six
11.	east	36.	south
12.	engines	38.	takeoff
14.	five	39.	tank
15.	fix	40.	target
16.	flight-lead	41.	the
17.	for	42.	thee
18.	four	43.	three
19.	fuel	44.	tower
20.	hydraulics	45.	two
21.	landing	46.	waypoint
22.	map	47.	west
23.	maverick	48.	wingman
24.	my	49.	zero
25.	nine		

Connected Speech Study Vocabulary Structure



28 September 1993

Appendix C. List of 392 Test Phrases

north nine zero	north four seven four nine point four seven
south nine zero	north three seven one four point six four
east one eight zero	north zero three zero six point two six
west one eight zero	north three seven zero six point nine eight
north one zero three one point seven one	north one seven three zero point zero three
north zero five five eight point zero three	south one two four zero point seven five
north six eight zero nine point four nine	south five seven two zero point six zero
north eight seven three seven point six seven	south two zero five four point six one
north three one four zero point five eight	south three six two four point two zero
north eight two three nine point two five	south four two five seven point eight four
north six eight four seven point two six	south eight four five three point two six
north four five two zero point four six	south four four five four point nine seven
north one one five five point six seven	south one six five two point eight three
north four nine zero eight point four zero	south five zero zero one point zero one
north five zero one six point five five	south six two two eight point zero three
north three three three seven point five four	south two eight two nine point zero eight
north six five four four point five two	south five nine five eight point nine eight
north seven four five seven point nine zero	south four two three six point six five
north zero zero five eight point two two	south two six three eight point three one
north eight seven one one point one four	south seven four zero one point two seven
north one four five two point two two	south two four three eight point six one
north one seven two two point six three	south eight three five eight point zero seven
north three four zero six point zero one	south six eight one one point four eight
north two six three eight point three zero	south six three five zero point nine eight
north two five two eight point five zero	south eight six zero seven point three two
north three four four zero point five zero	south one zero zero nine point five eight
north five eight four six point zero six	south eight four five four point six nine
north seven five four five point zero one	south seven eight three one point three eight
north five two four nine point seven three	south six four one eight point eight six
north two eight five three point one six	south zero nine two nine point seven four
north seven two zero two point zero zero	south seven five zero four point two eight
north seven two three seven point five eight	south five one five four point two two
north four five five four point five six	south six eight two five point four four
north three zero zero six point four three	south one zero one three point zero four
north two three two one point zero eight	south six one zero two point six zero
north five two two one point nine seven	south one four zero six point four nine
north one seven two zero point eight one	south six nine two three point eight four
north zero three four four point nine six	south five four two two point zero nine
north six four one six point four five	south six two five nine point three seven
north zero seven zero eight point six one	south six two zero five point two seven
north eight three one one point one six	south eight four two zero point one one
north three seven two six point four eight	south four six zero nine point seven five
north two nine two two point nine five	south seven one three two point five one
north four five five four point zero two	south three six two six point five five
north five five three nine point zero one	south five seven two five point zero five
north three five two eight point three two	south eight four four one point five three
north eight five two five point five nine	south six four two zero point three six

south six seven zero seven point nine eight
 south six two zero one point three two
 south six three five six point seven zero
 south two two two six point four four
 south one one four eight point three seven
 south two three five six point four nine
 east zero two one three four point six nine
 east one five five one zero point four one
 east one one nine two six point five one
 east one four three five five point eight five
 east zero nine zero four one point one nine
 east zero three nine one zero point four nine
 east zero five one four six point three two
 east zero five five three two point nine three
 east one two zero four three point two three
 east zero six seven one one point zero zero
 east one six six four six point eight eight
 east zero eight six one six point five five
 east one one nine two one point three four
 east zero one eight five three point five seven
 east one six five three four point seven six
 east one six eight three six point eight one
 east one five one four six point one four
 east one two zero one seven point nine one
 east zero seven zero zero two point eight nine
 east zero five three two eight point six five
 east zero zero six four three point six six
 east zero six nine zero three point eight two
 east zero nine two five zero point two nine
 east zero one six one seven point zero two
 east zero five seven three five point eight three
 east zero seven two four nine point nine two
 east zero three eight zero one point one six
 east one two five five three point one two
 east zero six seven five two point three one
 east one zero zero two seven point one five
 east one five nine zero four point six zero
 east one zero nine three two point four nine
 east zero seven four two three point one six
 east one zero six three nine point zero three
 east one six eight zero three point zero seven
 east zero nine two five zero point seven four
 east zero zero one three three point seven two
 east one seven seven five one point six eight
 east zero eight nine three two point four three
 east zero nine seven one zero point eight eight
 east zero four two five eight point seven one
 east one two zero three zero point two three
 east one five two zero one point one one

east zero eight three one five point three eight
 east one four two zero nine point six six
 east one four zero three five point one three
 east zero zero seven three three point six nine
 east zero zero one zero three point eight four
 west one two six five seven point three seven
 west zero five four zero three point three seven
 west one zero seven two nine point nine three
 west one one one one two point three one
 west zero nine five zero nine point five nine
 west one six four three one point seven five
 west zero three seven two nine point nine four
 west one zero five zero seven point three six
 west zero five two five two point three eight
 west zero four five three three point seven seven
 west one zero five two zero point eight nine
 west zero four eight two six point two three
 west zero five three zero six point four three
 west zero seven one two one point nine eight
 west zero five three four two point six six
 west one four six zero six point four zero
 west one one four four eight point nine one
 west zero eight zero one zero point five eight
 west one zero three three four point six four
 west one three six zero nine point zero five
 west one four six four two point seven three
 west one five four three five point three zero
 west one one five two nine point six six
 west zero eight eight three eight point zero nine
 west zero six five three seven point nine five
 west zero four one three six point one zero
 west one six seven two six point two six
 west one six zero one six point four two
 west one four five one zero point nine one
 west one four nine one four point eight one
 west zero eight eight zero one point one five
 west zero zero one two five point three two
 west zero three three five four point one two
 west zero four eight two four point three nine
 west zero three three three nine point nine eight
 west zero zero zero one four point six three
 west zero one nine five zero point three two
 west zero seven nine three four point three eight
 west one four six four zero point eight six
 west one zero two three five point five seven
 west zero seven six four four point one two
 west one six seven zero four point nine seven
 west zero six six two two point eight one
 west zero zero seven two five point eight nine

west one four six two seven point four one
west zero four two two six point nine six
west one five one five eight point three three
west one one five one seven point eight three

change waypoint one	select waypoint nine	show-me radar three	show-me my checklist
change waypoint two	show bandit one	show-me radar four	show fuel
change waypoint three	show bandit two	show-me radar five	show hydraulics
change waypoint four	show bandit three	show-me radar six	show engines
change waypoint five	show bandit four	show-me radar seven	show the fuel
change waypoint six	show bandit five	show-me radar eight	show the hydraulics
change waypoint seven	show bandit six	show-me radar nine	show thee engines
change waypoint eight	show bandit seven	show-me tank one	show my fuel
change waypoint nine	show bandit eight	show-me tank two	show my hydraulics
select amraam	show bandit nine	show-me tank three	show my engines
select maverick	show radar one	show-me tank four	show-me fuel
select air-to-air	show radar two	show-me tank five	show-me hydraulics
select air-to-ground	show radar three	show-me tank six	show-me engines
select bandit one	show radar four	show-me tank seven	show-me the fuel
select bandit two	show radar five	show-me tank eight	show-me the hydraulics
select bandit three	show radar six	show-me tank nine	show-me thee engines
select bandit four	show radar seven	show-me waypoint one	show-me my fuel
select bandit five	show radar eight	show-me waypoint two	show-me my hydraulics
select bandit six	show radar nine	show-me waypoint threeshow-me my engines	
select bandit seven	show tank one	show-me waypoint four	fix fuel
select bandit eight	show tank two	show-me waypoint five	fix hydraulics
select bandit nine	show tank three	show-me waypoint six	fix engines
select radar one	show tank four	show-me waypoint seven	fix the fuel
select radar two	show tank five	show-me waypoint eight	fix the hydraulics
select radar three	show tank six	show-me waypoint nine	fix thee engines
select radar four	show tank seven	show stores	fix my fuel
select radar five	show tank eight	show map	fix my hydraulics
select radar six	show tank nine	show target	fix my engines
select radar seven	show waypoint one	show checklist	configure takeoff
select radar eight	show waypoint two	show the stores	configure landing
select radar nine	show waypoint three	show the map	configure cruise
select tank one	show waypoint four	show the target	configure for takeoff
select tank two	show waypoint five	show the checklist	configure for landing
select tank three	show waypoint six	show my stores	configure for cruise
select tank four	show waypoint seven	show my map	setup takeoff
select tank five	show waypoint eight	show my target	setup landing
select tank six	show waypoint nine	show my checklist	setup cruise
select tank seven	show-me bandit one	show-me stores	setup for takeoff
select tank eight	show-me bandit two	show-me map	setup for landing
select tank nine	show-me bandit three	show-me target	setup for cruise
select waypoint one	show-me bandit four	show-me checklist	contact tower
select waypoint two	show-me bandit five	show-me the stores	contact awacs
select waypoint three	show-me bandit six	show-me the map	contact flight-lead
select waypoint four	show-me bandit seven	show-me the target	contact wingman
select waypoint five	show-me bandit eight	show-me the checklist	contact the tower
select waypoint six	show-me bandit nine	show-me my stores	contact thee awacs
select waypoint seven	show-me radar one	show-me my map	contact the flight-lead
select waypoint eight	show-me radar two	show-me my target	contact the wingman

contact my tower
contact my awacs
contact my flight-lead
contact my wingman

Appendix D. Subject Briefing

The purpose of this study is to test the recognition accuracy of a new connected speech recognition system.

During the next hour or so, you will be asked to use the microphone on the headset to speak the phrases that are presented on computer screen. There are 329 different phrases that will be presented. You will always be prompted when to say the next phrase.

The first 20 minutes of the study involves "training" the voice recognition system to recognize your voice. We do this by prompting you to say individual words and then phrases that contain these words. When you speak each word or phrase, the recognition system will remember how you spoke so that it can recognize the words and phrases the next time it hears them.

The second part of the study involves letting the voice recognition system actually recognize your voice. Again, the phrases to be spoken will be presented on the computer screen, in random order. We will take a short break after approximately 130 phrases, and again after 260 phrases.

Due to the amount of reading required during this session, you may on occasion misread a phrase. If this happens, I will simply present that phrase again.

You are a volunteer subject. Participation in this study is your choice. If at any time you wish to discontinue the testing and your participation, you may do so. In case of fire or emergency, leave through the CSIL main entrance.

Are there any questions?

Appendix E. Summary Data

Subject 1	Phrase Type	Word Recognition (WR)			Phrase Recognition (PR)			Intent Recognition (IR)			Totals for Intent Recognition (IR)		
		N Correct	N Words	Percent	N Correct	N Phrases	Percent	N Correct	N Phrases	Percent	Total (SN)	Total (SS)	Total (CN)
	Simple, No Siblings (SN)	59	59	100.00%	20	20	100.00%	20.00	20.00	100.00%	100.00%		
	Simple, Siblings (SS)	113	113	100.00%	40	41	97.56%	41	41.00	100.00%		100.00%	
	Complex, No Siblings (CN)	581	584	99.49%	68	70	97.14%	68.00	70.00	97.14%			97.14%
	Total	753.00	756.00	99.60%	128.00	131.00	97.71%	129.00	131.00	98.47%	100.00%	100.00%	97.14%
	Simple, No Siblings (SN)	38	38	100.00%	13	13	100.00%	13.00	13.00	100.00%	100.00%		
	Simple, Siblings (SS)	156	156	100.00%	54	54	100.00%	54	54.00	100.00%		100.00%	
	Complex, No Siblings (CN)	537	537	100.00%	64	64	100.00%	64.00	64.00	100.00%			100.00%
	Total	731.00	731.00	100.00%	131.00	131.00	100.00%	131.00	131.00	100.00%	100.00%	100.00%	100.00%
	Simple, No Siblings (SN)	46	46	100.00%	16	16	100.00%	16.00	16.00	100.00%	100.00%		
	Simple, Siblings (SS)	145	145	100.00%	51	52	98.08%	52	52.00	100.00%		100.00%	
	Complex, No Siblings (CN)	524	525	99.81%	61	62	98.39%	61.00	62.00	98.39%			98.39%
	Total	715.00	716.00	99.86%	128.00	130.00	98.46%	129.00	130.00	99.23%	100.00%	100.00%	98.39%
	Total for Trial 1	2,199.00	2,203.00	99.82%	387.00	392.00	98.72%	389.00	392.00	99.23%	100.00%	100.00%	98.47%
	Simple, No Siblings (SN)	59	59	100.00%	20	20	100.00%	20.00	20.00	100.00%	100.00%		
	Simple, Siblings (SS)	113	113	100.00%	40	41	97.56%	41	41.00	100.00%		100.00%	
	Complex, No Siblings (CN)	584	584	100.00%	70	70	100.00%	70.00	70.00	100.00%			100.00%
	Total	756.00	756.00	100.00%	130.00	131.00	99.24%	131.00	131.00	100.00%	100.00%	100.00%	100.00%
	Simple, No Siblings (SN)	38	38	100.00%	13	13	100.00%	13.00	13.00	100.00%	100.00%		
	Simple, Siblings (SS)	156	156	100.00%	53	54	98.15%	54	54.00	100.00%		100.00%	
	Complex, No Siblings (CN)	536	537	99.81%	63	64	98.44%	63.00	64.00	98.44%			98.44%
	Total	730.00	731.00	99.86%	129.00	131.00	98.47%	130.00	131.00	99.24%	100.00%	100.00%	98.44%
	Simple, No Siblings (SN)	46	46	100.00%	16	16	100.00%	16.00	16.00	100.00%	100.00%		
	Simple, Siblings (SS)	145	145	100.00%	52	52	100.00%	52	52.00	100.00%		100.00%	
	Complex, No Siblings (CN)	522	525	99.43%	59	62	95.16%	59.00	62.00	95.16%			95.16%
	Total	713.00	716.00	99.58%	127.00	130.00	97.69%	127.00	130.00	97.69%	100.00%	100.00%	95.16%
	Total for Trial 2	2,199.00	2,203.00	99.82%	386.00	392.00	98.47%	388.00	392.00	98.98%	100.00%	100.00%	97.96%
	Grand Total for Trials 1 and 2	4,398.00	4,406.00	99.82%	773.00	784.00	98.60%	777.00	784.00	99.11%	100.00%	100.00%	98.21%

Subject 2	Phrase Type	Word Recognition (WR)			Phrase Recognition (PR)			Intent Recognition (IR)			Totals for Intent Recognition (IR)		
		N Correct	N Words	Percent	N Correct	N Phrases	Percent	N Correct	N Phrases	Percent	Total (SN)	Total (SS)	Total (CN)
	Simple, No Siblings (SN)	63	63	100.00%	21	21	100.00%	21.00	21.00	100.00%	100.00%		
	Simple, Siblings (SS)	110	113	97.35%	40	41	97.56%	40	41.00	97.56%		97.56%	
	Complex, No Siblings (CN)	573	587	97.61%	63	69	91.30%	63.00	69.00	91.30%			91.30%
	Total	746.00	763.00	97.77%	124.00	131.00	94.66%	124.00	131.00	94.66%	100.00%	97.56%	91.30%
	Simple, No Siblings (SN)	44	44	100.00%	15	15	100.00%	15.00	15.00	100.00%	100.00%		
	Simple, Siblings (SS)	148	152	97.37%	50	53	94.34%	52	53.00	98.11%		98.11%	
	Complex, No Siblings (CN)	518	524	98.85%	58	63	92.06%	58.00	63.00	92.06%			92.06%
	Total	710.00	720.00	98.61%	123.00	131.00	93.89%	125.00	131.00	95.42%	100.00%	98.11%	92.06%
	Simple, No Siblings (SN)	36	36	100.00%	13	13	100.00%	13.00	13.00	100.00%	100.00%		
	Simple, Siblings (SS)	140	149	93.96%	48	53	90.57%	50	53.00	94.34%		94.34%	
	Complex, No Siblings (CN)	530	535	99.07%	59	64	92.19%	59.00	64.00	92.19%			92.19%
	Total	706.00	720.00	98.06%	120.00	130.00	92.31%	122.00	130.00	93.85%	100.00%	94.34%	92.19%
Total for Trial 1		2,162.00	2,203.00	98.14%	367.00	392.00	93.62%	371.00	392.00	94.64%	100.00%	96.60%	91.84%
	Simple, No Siblings (SN)	63	63	100.00%	21	21	100.00%	21.00	21.00	100.00%	100.00%		
	Simple, Siblings (SS)	109	113	96.46%	37	41	90.24%	38	41.00	92.68%		92.68%	
	Complex, No Siblings (CN)	585	587	99.66%	67	69	97.10%	67.00	69.00	97.10%			97.10%
	Total	757.00	763.00	99.21%	125.00	131.00	95.42%	126.00	131.00	96.18%	100.00%	92.68%	97.10%
	Simple, No Siblings (SN)	44	44	100.00%	15	15	100.00%	15.00	15.00	100.00%	100.00%		
	Simple, Siblings (SS)	150	152	98.68%	51	53	96.23%	52	53.00	98.11%		98.11%	
	Complex, No Siblings (CN)	521	524	99.43%	60	63	95.24%	60.00	63.00	95.24%			95.24%
	Total	715.00	720.00	99.31%	126.00	131.00	96.18%	127.00	131.00	96.95%	100.00%	98.11%	95.24%
	Simple, No Siblings (SN)	36	36	100.00%	13	13	100.00%	13.00	13.00	100.00%	100.00%		
	Simple, Siblings (SS)	147	149	98.66%	51	53	96.23%	53	53.00	100.00%		100.00%	
	Complex, No Siblings (CN)	535	535	100.00%	64	64	100.00%	64.00	64.00	100.00%			100.00%
	Total	718.00	720.00	99.72%	128.00	130.00	98.46%	130.00	130.00	100.00%	100.00%	100.00%	100.00%
Total for Trial 2		2,190.00	2,203.00	99.41%	379.00	392.00	96.68%	383.00	392.00	97.70%	100.00%	97.28%	97.45%
Grand Total for Trials 1 and 2		4,352.00	4,406.00	98.77%	746.00	784.00	95.15%	754.00	784.00	96.17%	100.00%	96.94%	94.64%

Subject 3	Phrase Type	Word Recognition (WR)			Phrase Recognition (PR)			Intent Recognition (IR)			Totals for Intent Recognition (IR)		
		N Correct	N Words	Percent	N Correct	N Phrases	Percent	N Correct	N Phrases	Percent	Total (SN)	Total (SS)	Total (CN)
	Simple, No Siblings (SN)	36	36	100.00%	12	12	100.00%	12.00	12.00	100.00%	100.00%		
	Simple, Siblings (SS)	124	131	94.66%	43	48	89.58%	47	48.00	97.92%		97.92%	
	Complex, No Siblings (CN)	587	588	99.83%	70	71	98.59%	70.00	71.00	98.59%			98.59%
	Total	747.00	755.00	98.94%	125.00	131.00	95.42%	129.00	131.00	98.47%	100.00%	97.92%	98.59%
	Simple, No Siblings (SN)	51	51	100.00%	17	17	100.00%	17.00	17.00	100.00%	100.00%		
	Simple, Siblings (SS)	134	140	95.71%	44	49	89.80%	49	49.00	100.00%		100.00%	
	Complex, No Siblings (CN)	548	552	99.28%	61	65	93.85%	61.00	65.00	93.85%			93.85%
	Total	733.00	743.00	98.65%	122.00	131.00	93.13%	127.00	131.00	96.95%	100.00%	100.00%	93.85%
	Simple, No Siblings (SN)	56	56	100.00%	20	20	100.00%	20.00	20.00	100.00%	100.00%		
	Simple, Siblings (SS)	139	143	97.20%	46	50	92.00%	50	50.00	100.00%		100.00%	
	Complex, No Siblings (CN)	501	506	99.01%	55	60	91.67%	55.00	60.00	91.67%			91.67%
	Total	696.00	705.00	98.72%	121.00	130.00	93.08%	125.00	130.00	96.15%	100.00%	100.00%	91.67%
	Total for Trial 1	2,176.00	2,203.00	98.77%	368.00	392.00	93.88%	381.00	392.00	97.19%	100.00%	99.32%	94.90%
	Simple, No Siblings (SN)	36	36	100.00%	12	12	100.00%	12.00	12.00	100.00%	100.00%		
	Simple, Siblings (SS)	126	131	96.18%	45	48	93.75%	48	48.00	100.00%		100.00%	
	Complex, No Siblings (CN)	584	588	99.32%	68	71	95.77%	68.00	71.00	95.77%			95.77%
	Total	746.00	755.00	98.81%	125.00	131.00	95.42%	128.00	131.00	97.71%	100.00%	100.00%	95.77%
	Simple, No Siblings (SN)	51	51	100.00%	17	17	100.00%	17.00	17.00	100.00%	100.00%		
	Simple, Siblings (SS)	135	140	96.43%	45	49	91.84%	49	49.00	100.00%		100.00%	
	Complex, No Siblings (CN)	549	552	99.46%	62	65	95.38%	62.00	65.00	95.38%			95.38%
	Total	735.00	743.00	98.92%	124.00	131.00	94.66%	128.00	131.00	97.71%	100.00%	100.00%	95.38%
	Simple, No Siblings (SN)	56	56	100.00%	20	20	100.00%	20.00	20.00	100.00%	100.00%		
	Simple, Siblings (SS)	140	143	97.90%	47	50	94.00%	50	50.00	100.00%		100.00%	
	Complex, No Siblings (CN)	502	506	99.21%	56	60	93.33%	56.00	60.00	93.33%			93.33%
	Total	698.00	705.00	99.01%	123.00	130.00	94.62%	126.00	130.00	96.92%	100.00%	100.00%	93.33%
	Total for Trial 2	2,179.00	2,203.00	98.91%	372.00	392.00	94.90%	382.00	392.00	97.45%	100.00%	100.00%	94.90%
	Grand Total for Trials 1 and 2	4,355.00	4,406.00	98.84%	740.00	784.00	94.39%	763.00	784.00	97.32%	100.00%	99.66%	94.90%

Subject	Phrase Type	Word Recognition (WR)			Phrase Recognition (PR)			Intent Recognition (IR)			Totals for Intent Recognition (IR)		
		N Correct	N Words	Percent	N Correct	N Phrases	Percent	N Correct	N Phrases	Percent	Total (SN)	Total (SS)	Total (CN)
4	Simple, No Siblings (SN)	59	59	100.00%	20	20	100.00%	20.00	20.00	100.00%	100.00%		
	Simple, Siblings (SS)	112	117	95.73%	36	41	87.80%	39	41.00	95.12%		95.12%	
	Complex, No Siblings (CN)	584	593	98.48%	61	70	87.14%	61.00	70.00	87.14%			87.14%
	Total	755.00	769.00	98.18%	117.00	131.00	89.31%	120.00	131.00	91.60%	100.00%	95.12%	87.14%
	Simple, No Siblings (SN)	43	43	100.00%	15	15	100.00%	15.00	15.00	100.00%	100.00%		
	Simple, Siblings (SS)	144	145	99.31%	51	52	98.08%	52	52.00	100.00%		100.00%	
	Complex, No Siblings (CN)	531	540	98.33%	56	64	87.50%	56.00	64.00	87.50%			87.50%
	Total	718.00	728.00	98.63%	122.00	131.00	93.13%	123.00	131.00	93.89%	100.00%	100.00%	87.50%
	Simple, No Siblings (SN)	40	41	97.56%	13	14	92.86%	13.00	14.00	92.86%	92.86%		
	Simple, Siblings (SS)	149	152	98.03%	51	54	94.44%	54	54.00	100.00%		100.00%	
	Complex, No Siblings (CN)	502	513	97.86%	52	62	83.87%	52.00	62.00	83.87%			83.87%
	Total	691.00	706.00	97.88%	116.00	130.00	89.23%	119.00	130.00	91.54%	92.86%	100.00%	83.87%
Total for Trial 1		2,164.00	2,203.00	98.23%	355.00	392.00	90.56%	362.00	392.00	92.35%	97.96%	98.64%	86.22%
	Simple, No Siblings (SN)	59	59	100.00%	20	20	100.00%	20.00	20.00	100.00%	100.00%		
	Simple, Siblings (SS)	116	117	99.15%	40	41	97.56%	41	41.00	100.00%		100.00%	
	Complex, No Siblings (CN)	582	593	98.15%	59	70	84.29%	59.00	70.00	84.29%			84.29%
	Total	757.00	769.00	98.44%	119.00	131.00	90.84%	120.00	131.00	91.60%	100.00%	100.00%	84.29%
	Simple, No Siblings (SN)	43	43	100.00%	15	15	100.00%	15.00	15.00	100.00%	100.00%		
	Simple, Siblings (SS)	137	145	94.48%	47	52	90.38%	50	52.00	96.15%		96.15%	
	Complex, No Siblings (CN)	536	540	99.26%	60	64	93.75%	60.00	64.00	93.75%			93.75%
	Total	716.00	728.00	98.35%	122.00	131.00	93.13%	125.00	131.00	95.42%	100.00%	96.15%	93.75%
	Simple, No Siblings (SN)	41	41	100.00%	14	14	100.00%	14.00	14.00	100.00%	100.00%		
	Simple, Siblings (SS)	148	152	97.37%	51	54	94.44%	54	54.00	100.00%		100.00%	
	Complex, No Siblings (CN)	508	513	99.03%	57	62	91.94%	57.00	62.00	91.94%			91.94%
	Total	697.00	706.00	98.73%	122.00	130.00	93.85%	125.00	130.00	96.15%	100.00%	100.00%	91.94%
Total for Trial 2		2,170.00	2,203.00	98.50%	363.00	392.00	92.60%	370.00	392.00	94.39%	100.00%	98.64%	89.80%
Grand Total for Trials 1 and 2		4,334.00	4,406.00	98.37%	718.00	784.00	91.58%	732.00	784.00	93.37%	98.98%	98.64%	88.01%

Subject 5	Phrase Type	Word Recognition (WR)				Phrase Recognition (PR)				Intent Recognition (IR)				Totals for Intent Recognition (IR)			
		N Correct	N Words	Percent		N Correct	N Phrases	Percent		N Correct	N Phrases	Percent		Total (SN)	Total (SS)	Total (CN)	
	Simple, No Siblings (SN)	42	44	95.45%		14	15	93.33%		14.00	15.00	93.33%		93.33%			
	Simple, Siblings (SS)	140	146	95.89%		48	53	90.57%		52	53.00	98.11%			98.11%		
	Complex, No Siblings (CN)	509	516	98.64%		56	63	88.89%		56.00	63.00	88.89%				88.89%	
	Total	691.00	706.00	97.88%		118.00	131.00	90.08%		122.00	131.00	93.13%		93.33%	98.11%	88.89%	
	Simple, No Siblings (SN)	54	57	94.74%		17	20	85.00%		17.00	20.00	85.00%		85.00%			
	Simple, Siblings (SS)	128	135	94.81%		40	47	85.11%		45	47.00	95.74%			95.74%		
	Complex, No Siblings (CN)	541	550	98.36%		55	64	85.94%		55.00	64.00	85.94%				85.94%	
	Total	723.00	742.00	97.44%		112.00	131.00	85.50%		117.00	131.00	89.31%		85.00%	95.74%	85.94%	
	Simple, No Siblings (SN)	40	42	95.24%		12	14	85.71%		12.00	14.00	85.71%		85.71%			
	Simple, Siblings (SS)	128	133	96.24%		42	47	89.36%		47	47.00	100.00%			100.00%		
	Complex, No Siblings (CN)	573	580	98.79%		62	69	89.86%		62.00	69.00	89.86%				89.86%	
	Total	741.00	755.00	98.15%		116.00	130.00	89.23%		121.00	130.00	93.08%		85.71%	100.00%	89.86%	
	Total for Trial 1	2,155.00	2,203.00	97.82%		346.00	392.00	88.27%		360.00	392.00	91.84%		87.76%	97.96%	88.27%	
	Simple, No Siblings (SN)	44	44	100.00%		15	15	100.00%		15.00	15.00	100.00%		100.00%			
	Simple, Siblings (SS)	139	146	95.21%		47	53	88.68%		50	53.00	94.34%			94.34%		
	Complex, No Siblings (CN)	503	516	97.48%		51	63	80.95%		51.00	63.00	80.95%				80.95%	
	Total	686.00	706.00	97.17%		113.00	131.00	86.26%		116.00	131.00	88.55%		100.00%	94.34%	80.95%	
	Simple, No Siblings (SN)	55	57	96.49%		18	20	90.00%		18.00	20.00	90.00%		90.00%			
	Simple, Siblings (SS)	124	135	91.85%		37	47	78.72%		45	47.00	95.74%			95.74%		
	Complex, No Siblings (CN)	541	550	98.36%		56	64	87.50%		56.00	64.00	87.50%				87.50%	
	Total	720.00	742.00	97.04%		111.00	131.00	84.73%		119.00	131.00	90.84%		90.00%	95.74%	87.50%	
	Simple, No Siblings (SN)	40	42	95.24%		12	14	85.71%		12.00	14.00	85.71%		85.71%			
	Simple, Siblings (SS)	123	133	92.48%		37	47	78.72%		43	47.00	91.49%			91.49%		
	Complex, No Siblings (CN)	574	580	98.97%		63	69	91.30%		63.00	69.00	91.30%				91.30%	
	Total	737.00	755.00	97.62%		112.00	130.00	86.15%		118.00	130.00	90.77%		85.71%	91.49%	91.30%	
	Total for Trial 2	2,143.00	2,203.00	97.28%		336.00	392.00	85.71%		353.00	392.00	90.05%		91.84%	93.88%	86.73%	
	Grand Total for Trials 1 and 2	4,298.00	4,406.00	97.55%		682.00	784.00	86.99%		713.00	784.00	90.94%		89.80%	95.92%	87.50%	

Subject	Phrase Type	Word Recognition (WR)			Phrase Recognition (PR)			Intent Recognition (IR)			Totals for Intent Recognition (IR)		
		N Correct	N Words	Percent	N Correct	N Phrases	Percent	N Correct	N Phrases	Percent	Total (SN)	Total (SS)	Total (CN)
6	Simple, No Siblings (SN)	53	53	100.00%	18	18	100.00%	18.00	18.00	100.00%	100.00%		
	Simple, Siblings (SS)	158	159	99.37%	55	56	98.21%	55	56.00	98.21%		98.21%	
	Complex, No Siblings (CN)	479	479	100.00%	57	57	100.00%	57.00	57.00	100.00%			100.00%
	Total	690.00	691.00	99.86%	130.00	131.00	99.24%	130.00	131.00	99.24%	100.00%	98.21%	100.00%
	Simple, No Siblings (SN)	49	49	100.00%	17	17	100.00%	17.00	17.00	100.00%	100.00%		
	Simple, Siblings (SS)	126	127	99.21%	45	46	97.83%	46	46.00	100.00%		100.00%	
	Complex, No Siblings (CN)	574	575	99.83%	67	68	98.53%	67.00	68.00	98.53%			98.53%
	Total	749.00	751.00	99.73%	129.00	131.00	98.47%	130.00	131.00	99.24%	100.00%	100.00%	98.53%
	Simple, No Siblings (SN)	41	41	100.00%	14	14	100.00%	14.00	14.00	100.00%	100.00%		
	Simple, Siblings (SS)	126	128	98.44%	43	45	95.56%	45	45.00	100.00%		100.00%	
	Complex, No Siblings (CN)	591	592	99.83%	70	71	98.59%	70.00	71.00	98.59%			98.59%
	Total	758.00	761.00	99.61%	127.00	130.00	97.69%	129.00	130.00	99.23%	100.00%	100.00%	98.59%
Total for Trial 1		2,197.00	2,203.00	99.73%	386.00	392.00	98.47%	389.00	392.00	99.23%	100.00%	99.32%	98.98%
	Simple, No Siblings (SN)	53	53	100.00%	18	18	100.00%	18.00	18.00	100.00%	100.00%		
	Simple, Siblings (SS)	158	159	99.37%	55	56	98.21%	56	56.00	100.00%		100.00%	
	Complex, No Siblings (CN)	476	479	99.37%	54	57	94.74%	54.00	57.00	94.74%			94.74%
	Total	687.00	691.00	99.42%	127.00	131.00	96.95%	128.00	131.00	97.71%	100.00%	100.00%	94.74%
	Simple, No Siblings (SN)	49	49	100.00%	17	17	100.00%	17.00	17.00	100.00%	100.00%		
	Simple, Siblings (SS)	125	127	98.43%	45	46	97.83%	46	46.00	100.00%		100.00%	
	Complex, No Siblings (CN)	574	575	99.83%	67	68	98.53%	67.00	68.00	98.53%			98.53%
	Total	748.00	751.00	99.60%	129.00	131.00	98.47%	130.00	131.00	99.24%	100.00%	100.00%	98.53%
	Simple, No Siblings (SN)	41	41	100.00%	14	14	100.00%	14.00	14.00	100.00%	100.00%		
	Simple, Siblings (SS)	127	128	99.22%	44	45	97.78%	45	45.00	100.00%		100.00%	
	Complex, No Siblings (CN)	591	592	99.83%	70	71	98.59%	70.00	71.00	98.59%			98.59%
	Total	759.00	761.00	99.74%	128.00	130.00	98.46%	129.00	130.00	99.23%	100.00%	100.00%	98.59%
Total for Trial 2		2,194.00	2,203.00	99.59%	384.00	392.00	97.96%	387.00	392.00	98.72%	100.00%	100.00%	97.45%
Grand Total for Trials 1 and 2		4,391.00	4,406.00	99.66%	770.00	784.00	98.21%	776.00	784.00	98.98%	100.00%	99.66%	98.21%

Subject	Phrase Type	Word Recognition (WR)			Phrase Recognition (PR)			Intent Recognition (IR)			Totals for Intent Recognition (IR)		
		N Correct	N Words	Percent	N Correct	N Phrases	Percent	N Correct	N Phrases	Percent	Total (SN)	Total (SS)	Total (CN)
7	Simple, No Siblings (SN)	58	58	100.00%	20	20	100.00%	20.00	20.00	100.00%	100.00%		
	Simple, Siblings (SS)	130	134	97.01%	43	47	91.49%	47	47.00	100.00%		100.00%	
	Complex, No Siblings (CN)	531	531	100.00%	64	64	100.00%	64.00	64.00	100.00%			100.00%
	Total	719.00	723.00	99.45%	127.00	131.00	96.95%	131.00	131.00	100.00%	100.00%	100.00%	100.00%
	Simple, No Siblings (SN)	37	37	100.00%	13	13	100.00%	13.00	13.00	100.00%	100.00%		
	Simple, Siblings (SS)	139	143	97.20%	48	52	92.31%	52	52.00	100.00%		100.00%	
	Complex, No Siblings (CN)	557	558	99.82%	65	66	98.48%	65.00	66.00	98.48%			98.48%
	Total	733.00	738.00	99.32%	126.00	131.00	96.18%	130.00	131.00	99.24%	100.00%	100.00%	98.48%
	Simple, No Siblings (SN)	48	48	100.00%	16	16	100.00%	16.00	16.00	100.00%	100.00%		
	Simple, Siblings (SS)	134	137	97.81%	45	48	93.75%	48	48.00	100.00%		100.00%	
	Complex, No Siblings (CN)	556	557	99.82%	65	66	98.48%	65.00	66.00	98.48%			98.48%
	Total	738.00	742.00	99.46%	126.00	130.00	96.92%	129.00	130.00	99.23%	100.00%	100.00%	98.48%
Total for Trial 1		2,190.00	2,203.00	99.41%	379.00	392.00	96.68%	390.00	392.00	99.49%	100.00%	100.00%	98.98%
	Simple, No Siblings (SN)	58	58	100.00%	20	20	100.00%	20.00	20.00	100.00%	100.00%		
	Simple, Siblings (SS)	128	134	95.52%	41	47	87.23%	47	47.00	100.00%		100.00%	
	Complex, No Siblings (CN)	529	531	99.62%	62	64	96.88%	62.00	64.00	96.88%			96.88%
	Total	715.00	723.00	98.89%	123.00	131.00	93.89%	129.00	131.00	98.47%	100.00%	100.00%	96.88%
	Simple, No Siblings (SN)	37	37	100.00%	13	13	100.00%	13.00	13.00	100.00%	100.00%		
	Simple, Siblings (SS)	140	143	97.90%	48	52	92.31%	52	52.00	100.00%		100.00%	
	Complex, No Siblings (CN)	558	558	100.00%	66	66	100.00%	66.00	66.00	100.00%			100.00%
	Total	735.00	738.00	99.59%	127.00	131.00	96.95%	131.00	131.00	100.00%	100.00%	100.00%	100.00%
	Simple, No Siblings (SN)	48	48	100.00%	16	16	100.00%	16.00	16.00	100.00%	100.00%		
	Simple, Siblings (SS)	135	137	98.54%	46	48	95.83%	48	48.00	100.00%		100.00%	
	Complex, No Siblings (CN)	555	557	99.64%	64	66	96.97%	64.00	66.00	96.97%			96.97%
	Total	738.00	742.00	99.46%	126.00	130.00	96.92%	128.00	130.00	98.46%	100.00%	100.00%	96.97%
Total for Trial 2		2,188.00	2,203.00	99.32%	376.00	392.00	95.92%	388.00	392.00	98.98%	100.00%	100.00%	97.96%
Grand Total for Trials 1 and 2		4,378.00	4,406.00	99.36%	755.00	784.00	96.30%	778.00	784.00	99.23%	100.00%	100.00%	98.47%

Subject	Phrase Type	Word Recognition (WR)			Phrase Recognition (PR)			Intent Recognition (IR)			Totals for Intent Recognition (IR)		
		N Correct	N Words	Percent	N Correct	N Phrases	Percent	N Correct	N Phrases	Percent	Total (SN)	Total (SS)	Total (CN)
8	Simple, No Siblings (SN)	56	56	100.00%	19	19	100.00%	19.00	19.00	100.00%	100.00%		
	Simple, Siblings (SS)	141	150	94.00%	46	53	86.79%	53	53.00	100.00%		100.00%	
	Complex, No Siblings (CN)	490	491	99.80%	58	59	98.31%	58.00	59.00	98.31%			98.31%
	Total	687.00	697.00	98.57%	123.00	131.00	93.89%	130.00	131.00	99.24%	100.00%	100.00%	98.31%
	Simple, No Siblings (SN)	41	41	100.00%	14	14	100.00%	14.00	14.00	100.00%	100.00%		
	Simple, Siblings (SS)	125	128	97.66%	43	46	93.48%	46	46.00	100.00%		100.00%	
	Complex, No Siblings (CN)	594	596	99.66%	69	71	97.18%	69.00	71.00	97.18%			97.18%
	Total	760.00	765.00	99.35%	126.00	131.00	96.18%	129.00	131.00	98.47%	100.00%	100.00%	97.18%
	Simple, No Siblings (SN)	46	46	100.00%	16	16	100.00%	16.00	16.00	100.00%	100.00%		
	Simple, Siblings (SS)	132	136	97.06%	45	48	93.75%	48	48.00	100.00%		100.00%	
	Complex, No Siblings (CN)	556	559	99.46%	63	66	95.45%	63.00	66.00	95.45%			95.45%
	Total	734.00	741.00	99.06%	124.00	130.00	95.38%	127.00	130.00	97.69%	100.00%	100.00%	95.45%
Total for Trial 1		2,181.00	2,203.00	99.00%	373.00	392.00	95.15%	386.00	392.00	98.47%	100.00%	100.00%	96.94%
	Simple, No Siblings (SN)	56	56	100.00%	19	19	100.00%	19.00	19.00	100.00%	100.00%		
	Simple, Siblings (SS)	140	150	93.33%	44	53	83.02%	53	53.00	100.00%		100.00%	
	Complex, No Siblings (CN)	487	491	99.19%	56	59	94.92%	56.00	59.00	94.92%			94.92%
	Total	683.00	697.00	97.99%	119.00	131.00	90.84%	128.00	131.00	97.71%	100.00%	100.00%	94.92%
	Simple, No Siblings (SN)	41	41	100.00%	14	14	100.00%	14.00	14.00	100.00%	100.00%		
	Simple, Siblings (SS)	122	128	95.31%	40	46	86.96%	46	46.00	100.00%		100.00%	
	Complex, No Siblings (CN)	594	596	99.66%	69	71	97.18%	69.00	71.00	97.18%			97.18%
	Total	757.00	765.00	98.95%	123.00	131.00	93.89%	129.00	131.00	98.47%	100.00%	100.00%	97.18%
	Simple, No Siblings (SN)	46	46	100.00%	16	16	100.00%	16.00	16.00	100.00%	100.00%		
	Simple, Siblings (SS)	131	136	96.32%	44	48	91.67%	47	48.00	97.92%		97.92%	
	Complex, No Siblings (CN)	542	559	96.96%	51	66	77.27%	51.00	66.00	77.27%			77.27%
	Total	719.00	741.00	97.03%	111.00	130.00	85.38%	114.00	130.00	87.69%	100.00%	97.92%	77.27%
Total for Trial 2		2,159.00	2,203.00	98.00%	353.00	392.00	90.05%	371.00	392.00	94.64%	100.00%	99.32%	89.80%
Grand Total for Trials 1 and 2		4,340.00	4,406.00	98.50%	726.00	784.00	92.60%	757.00	784.00	96.56%	100.00%	99.66%	93.37%

Subject	Phrase Type	Word Recognition (WR)			Phrase Recognition (PR)			Intent Recognition (IR)			Totals for Intent Recognition (IR)		
		N Correct	N Words	Percent	N Correct	N Phrases	Percent	N Correct	N Phrases	Percent	Total (SN)	Total (SS)	Total (CN)
9	Simple, No Siblings (SN)	35	36	97.22%	12	13	92.31%	12.00	13.00	92.31%	92.31%		
	Simple, Siblings (SS)	155	155	100.00%	55	55	100.00%	55	55.00	100.00%		100.00%	
	Complex, No Siblings (CN)	532	533	99.81%	62	63	98.41%	62.00	63.00	98.41%			98.41%
	Total	722.00	724.00	99.72%	129.00	131.00	98.47%	129.00	131.00	98.47%	92.31%	100.00%	98.41%
	Simple, No Siblings (SN)	54	54	100.00%	18	18	100.00%	18.00	18.00	100.00%	100.00%		
	Simple, Siblings (SS)	146	149	97.99%	49	52	94.23%	52	52.00	100.00%		100.00%	
	Complex, No Siblings (CN)	514	514	100.00%	61	61	100.00%	61.00	61.00	100.00%			100.00%
	Total	714.00	717.00	99.58%	128.00	131.00	97.71%	131.00	131.00	100.00%	100.00%	100.00%	100.00%
	Simple, No Siblings (SN)	51	53	96.23%	17	18	94.44%	17.00	18.00	94.44%	94.44%		
	Simple, Siblings (SS)	105	110	95.45%	35	40	87.50%	40	40.00	100.00%		100.00%	
	Complex, No Siblings (CN)	598	599	99.83%	71	72	98.61%	71.00	72.00	98.61%			98.61%
	Total	754.00	762.00	98.95%	123.00	130.00	94.62%	128.00	130.00	98.46%	94.44%	100.00%	98.61%
Total for Trial 1		2,190.00	2,203.00	99.41%	380.00	392.00	96.94%	388.00	392.00	98.98%	95.92%	100.00%	98.98%
	Simple, No Siblings (SN)	36	36	100.00%	13	13	100.00%	13.00	13.00	100.00%	100.00%		
	Simple, Siblings (SS)	152	155	98.06%	53	55	96.36%	54	55.00	98.18%		98.18%	
	Complex, No Siblings (CN)	532	533	99.81%	62	63	98.41%	62.00	63.00	98.41%			98.41%
	Total	720.00	724.00	99.45%	128.00	131.00	97.71%	129.00	131.00	98.47%	100.00%	98.18%	98.41%
	Simple, No Siblings (SN)	54	54	100.00%	18	18	100.00%	18.00	18.00	100.00%	100.00%		
	Simple, Siblings (SS)	146	149	97.99%	49	52	94.23%	52	52.00	100.00%		100.00%	
	Complex, No Siblings (CN)	514	514	100.00%	61	61	100.00%	61.00	61.00	100.00%			100.00%
	Total	714.00	717.00	99.58%	128.00	131.00	97.71%	131.00	131.00	100.00%	100.00%	100.00%	100.00%
	Simple, No Siblings (SN)	53	53	100.00%	18	18	100.00%	18.00	18.00	100.00%	100.00%		
	Simple, Siblings (SS)	107	110	97.27%	37	40	92.50%	40	40.00	100.00%		100.00%	
	Complex, No Siblings (CN)	599	599	100.00%	72	72	100.00%	72.00	72.00	100.00%			100.00%
	Total	759.00	762.00	99.61%	127.00	130.00	97.69%	130.00	130.00	100.00%	100.00%	100.00%	100.00%
Total for Trial 2		2,193.00	2,203.00	99.55%	383.00	392.00	97.70%	390.00	392.00	99.49%	100.00%	99.32%	99.49%
Grand Total for Trials 1 and 2		4,383.00	4,406.00	99.48%	763.00	784.00	97.32%	778.00	784.00	99.23%	97.96%	99.66%	99.23%

Subject	Phrase Type	Word Recognition (WR)				Phrase Recognition (PR)				Intent Recognition (IR)				Totals for Intent Recognition (IR)			
		N Correct		N Words		Percent		N Correct		N Phrases		Percent		N Correct		N Phrases	
		N Correct		N Words		Percent		N Correct		N Phrases		Percent		N Correct		N Phrases	
10	Simple, No Siblings (SN)	50	50	100.00%	17	17	100.00%	17	17	100.00%	17.00	100.00%	100.00%	17.00	17.00	100.00%	100.00%
	Simple, Siblings (SS)	134	136	98.53%	47	49	95.92%	47	49	95.92%	49	100.00%	100.00%	49	49.00	100.00%	100.00%
	Complex, No Siblings (CN)	542	543	99.82%	64	65	98.46%	64	65	98.46%	64.00	98.46%	98.46%	64.00	65.00	98.46%	98.46%
	Total	726.00	729.00	99.59%	128.00	131.00	97.71%	128.00	131.00	97.71%	130.00	99.24%	100.00%	130.00	131.00	100.00%	98.46%
	Simple, No Siblings (SN)	49	49	100.00%	17	17	100.00%	17	17	100.00%	17.00	100.00%	100.00%	17.00	17.00	100.00%	100.00%
	Simple, Siblings (SS)	139	139	100.00%	49	49	100.00%	49	49	100.00%	49	100.00%	100.00%	49	49.00	100.00%	100.00%
	Complex, No Siblings (CN)	549	549	100.00%	65	65	100.00%	65	65	100.00%	65.00	100.00%	100.00%	65.00	65.00	100.00%	100.00%
	Total	737.00	737.00	100.00%	131.00	131.00	100.00%	131.00	131.00	100.00%	131.00	100.00%	100.00%	131.00	131.00	100.00%	100.00%
	Simple, No Siblings (SN)	44	44	100.00%	15	15	100.00%	15	15	100.00%	15.00	100.00%	100.00%	15.00	15.00	100.00%	100.00%
	Simple, Siblings (SS)	138	139	99.28%	48	49	97.96%	48	49	97.96%	48	97.96%	97.96%	48	49.00	97.96%	97.96%
	Complex, No Siblings (CN)	553	554	99.82%	65	66	98.48%	65	66	98.48%	65.00	98.48%	98.48%	65.00	66.00	98.48%	98.48%
	Total	735.00	737.00	99.73%	128.00	130.00	98.46%	128.00	130.00	98.46%	128.00	98.46%	98.46%	128.00	130.00	97.96%	98.48%
	Total for Trial 1	2,198.00	2,203.00	99.77%	387.00	392.00	98.72%	387.00	392.00	98.72%	389.00	99.23%	100.00%	389.00	392.00	99.32%	98.98%
	Simple, No Siblings (SN)	50	50	100.00%	17	17	100.00%	17	17	100.00%	17.00	100.00%	100.00%	17.00	17.00	100.00%	100.00%
	Simple, Siblings (SS)	134	136	98.53%	47	49	95.92%	47	49	95.92%	49	100.00%	100.00%	49	49.00	100.00%	100.00%
	Complex, No Siblings (CN)	543	543	100.00%	65	65	100.00%	65	65	100.00%	65.00	100.00%	100.00%	65.00	65.00	100.00%	100.00%
	Total	727.00	729.00	99.73%	129.00	131.00	98.47%	129.00	131.00	98.47%	131.00	100.00%	100.00%	131.00	131.00	100.00%	100.00%
	Simple, No Siblings (SN)	49	49	100.00%	17	17	100.00%	17	17	100.00%	17.00	100.00%	100.00%	17.00	17.00	100.00%	100.00%
	Simple, Siblings (SS)	139	139	100.00%	49	49	100.00%	49	49	100.00%	49	100.00%	100.00%	49	49.00	100.00%	100.00%
	Complex, No Siblings (CN)	549	549	100.00%	65	65	100.00%	65	65	100.00%	65.00	100.00%	100.00%	65.00	65.00	100.00%	100.00%
	Total	737.00	737.00	100.00%	131.00	131.00	100.00%	131.00	131.00	100.00%	131.00	100.00%	100.00%	131.00	131.00	100.00%	100.00%
	Simple, No Siblings (SN)	44	44	100.00%	15	15	100.00%	15	15	100.00%	15.00	100.00%	100.00%	15.00	15.00	100.00%	100.00%
	Simple, Siblings (SS)	138	139	99.28%	48	49	97.96%	48	49	97.96%	49	100.00%	100.00%	49	49.00	100.00%	100.00%
	Complex, No Siblings (CN)	554	554	100.00%	66	66	100.00%	66	66	100.00%	66.00	100.00%	100.00%	66.00	66.00	100.00%	100.00%
	Total	736.00	737.00	99.86%	129.00	130.00	99.23%	129.00	130.00	99.23%	130.00	100.00%	100.00%	130.00	130.00	100.00%	100.00%
	Total for Trial 2	2,200.00	2,203.00	99.86%	389.00	392.00	99.23%	389.00	392.00	99.23%	392.00	100.00%	100.00%	392.00	392.00	100.00%	100.00%
Grand Total for Trials 1 and 2		4,398.00	4,406.00	99.82%	776.00	784.00	98.98%	776.00	784.00	98.98%	781.00	99.62%	100.00%	781.00	784.00	99.66%	99.49%

Subject	Phrase Type	Word Recognition (WR)			Phrase Recognition (PR)			Intent Recognition (IR)			Totals for Intent Recognition (IR)		
		N Correct	N Words	Percent	N Correct	N Phrases	Percent	N Correct	N Phrases	Percent	Total (SN)	Total (SS)	Total (CN)
11	Simple, No Siblings (SN)	48	48	100.00%	17	17	100.00%	17.00	17.00	100.00%	100.00%		
	Simple, Siblings (SS)	144	146	98.63%	48	51	94.12%	51	51.00	100.00%		100.00%	
	Complex, No Siblings (CN)	521	523	99.62%	61	63	96.83%	61.00	63.00	96.83%			96.83%
	Total	713.00	717.00	99.44%	126.00	131.00	96.18%	129.00	131.00	98.47%	100.00%	100.00%	96.83%
	Simple, No Siblings (SN)	56	56	100.00%	19	19	100.00%	19.00	19.00	100.00%	100.00%		
	Simple, Siblings (SS)	119	121	98.35%	42	44	95.45%	44	44.00	100.00%		100.00%	
	Complex, No Siblings (CN)	569	570	99.82%	67	68	98.53%	67.00	68.00	98.53%			98.53%
	Total	744.00	747.00	99.60%	128.00	131.00	97.71%	130.00	131.00	99.24%	100.00%	100.00%	98.53%
	Simple, No Siblings (SN)	39	39	100.00%	13	13	100.00%	13.00	13.00	100.00%	100.00%		
	Simple, Siblings (SS)	145	147	98.64%	50	52	96.15%	52	52.00	100.00%		100.00%	
	Complex, No Siblings (CN)	552	553	99.82%	64	65	98.46%	64.00	65.00	98.46%			98.46%
	Total	736.00	739.00	99.59%	127.00	130.00	97.69%	129.00	130.00	99.23%	100.00%	100.00%	98.46%
	Total for Trial 1	2,193.00	2,203.00	99.55%	381.00	392.00	97.19%	388.00	392.00	98.98%	100.00%	100.00%	97.96%
	Simple, No Siblings (SN)	48	48	100.00%	17	17	100.00%	17.00	17.00	100.00%	100.00%		
	Simple, Siblings (SS)	143	146	97.95%	48	51	94.12%	51	51.00	100.00%		100.00%	
	Complex, No Siblings (CN)	520	523	99.43%	62	63	98.41%	62.00	63.00	98.41%			98.41%
	Total	711.00	717.00	99.16%	127.00	131.00	96.95%	130.00	131.00	99.24%	100.00%	100.00%	98.41%
	Simple, No Siblings (SN)	56	56	100.00%	19	19	100.00%	19.00	19.00	100.00%	100.00%		
	Simple, Siblings (SS)	118	121	97.52%	41	44	93.18%	43	44.00	97.73%		97.73%	
	Complex, No Siblings (CN)	566	570	99.30%	64	68	94.12%	64.00	68.00	94.12%			94.12%
	Total	740.00	747.00	99.06%	124.00	131.00	94.66%	126.00	131.00	96.18%	100.00%	97.73%	94.12%
	Simple, No Siblings (SN)	39	39	100.00%	13	13	100.00%	13.00	13.00	100.00%	100.00%		
	Simple, Siblings (SS)	145	147	98.64%	50	52	96.15%	51	52.00	98.08%		98.08%	
	Complex, No Siblings (CN)	544	553	98.37%	63	65	96.92%	63.00	65.00	96.92%			96.92%
	Total	728.00	739.00	98.51%	126.00	130.00	96.92%	127.00	130.00	97.69%	100.00%	98.08%	96.92%
	Total for Trial 2	2,179.00	2,203.00	98.91%	377.00	392.00	96.17%	383.00	392.00	97.70%	100.00%	98.64%	96.43%
	Grand Total for Trials 1 and 2	4,372.00	4,406.00	99.23%	758.00	784.00	96.68%	771.00	784.00	98.34%	100.00%	99.32%	97.19%

Summary Data for All Subjects (1 - 11)

All Subjects	Phrase Type	Word Recognition (WR)			Phrase Recognition (PR)			Intent Recognition (IR)			Totals for Intent Recognition (IR)		
		N Correct	N Words	Percent	N Correct	N Phrases	Percent	N Correct	N Phrases	Percent	Total (SN)	Total (SS)	Total (CN)
	Simple, No Siblings (SN)	559	562	99.47%	190	192	98.96%	190.00	192.00	98.96%	98.96%		
	Simple, Siblings (SS)	1461	1500	97.40%	501	535	93.64%	529	535.00	98.88%		98.88%	
	Complex, No Siblings (CN)	5929	5968	99.35%	684	714	95.80%	684.00	714.00	95.80%			95.80%
	Total	7,949.00	8,030.00	98.99%	1,375.00	1,441.00	95.42%	1,403.00	1,441.00	97.36%	98.96%	98.88%	95.80%
	Simple, No Siblings (SN)	516	519	99.42%	175	178	98.31%	175.00	178.00	98.31%	98.31%		
	Simple, Siblings (SS)	1504	1535	97.98%	515	544	94.67%	541	544.00	99.45%		99.45%	
	Complex, No Siblings (CN)	6032	6065	99.46%	688	719	95.69%	688.00	719.00	95.69%			95.69%
	Total	8,052.00	8,119.00	99.17%	1,378.00	1,441.00	95.63%	1,404.00	1,441.00	97.43%	98.31%	99.45%	95.69%
	Simple, No Siblings (SN)	487	492	98.98%	165	169	97.63%	165.00	169.00	97.63%	97.63%		
	Simple, Siblings (SS)	1481	1519	97.50%	504	538	93.68%	534	538.00	99.26%		99.26%	
	Complex, No Siblings (CN)	6036	6073	99.39%	687	723	95.02%	687.00	723.00	95.02%			95.02%
	Total	8,004.00	8,084.00	99.01%	1,356.00	1,430.00	94.83%	1,386.00	1,430.00	96.92%	97.63%	99.26%	95.02%
	Total for Trial 1	24,005.00	24,233.00	99.06%	4,109.00	4,312.00	95.29%	4,193.00	4,312.00	97.24%	98.33%	99.20%	95.50%
	Simple, No Siblings (SN)	562	562	100.00%	192	192	100.00%	192.00	192.00	100.00%	100.00%		
	Simple, Siblings (SS)	1458	1500	97.20%	497	535	92.90%	528	535.00	98.69%		98.69%	
	Complex, No Siblings (CN)	5925	5968	99.28%	676	714	94.68%	676.00	714.00	94.68%			94.68%
	Total	7,945.00	8,030.00	98.94%	1,365.00	1,441.00	94.73%	1,396.00	1,441.00	96.88%	100.00%	98.69%	94.68%
	Simple, No Siblings (SN)	517	519	99.61%	176	178	98.88%	176.00	178.00	98.88%	98.88%		
	Simple, Siblings (SS)	1492	1535	97.20%	505	544	92.83%	538	544.00	98.90%		98.90%	
	Complex, No Siblings (CN)	6037	6065	99.54%	693	719	96.38%	693.00	719.00	96.38%			96.38%
	Total	8,046.00	8,119.00	99.10%	1,374.00	1,441.00	95.35%	1,407.00	1,441.00	97.64%	98.88%	98.90%	96.38%
	Simple, No Siblings (SN)	490	492	99.59%	167	169	98.82%	167.00	169.00	98.82%	98.82%		
	Simple, Siblings (SS)	1486	1519	97.83%	507	538	94.24%	532	538.00	98.88%		98.88%	
	Complex, No Siblings (CN)	6026	6073	99.23%	685	723	94.74%	685.00	723.00	94.74%			94.74%
	Total	8,002.00	8,084.00	98.99%	1,359.00	1,430.00	95.03%	1,384.00	1,430.00	96.78%	98.82%	98.88%	94.74%
	Total for Trial 2	23,993.00	24,233.00	99.01%	4,098.00	4,312.00	95.04%	4,187.00	4,312.00	97.10%	99.26%	98.82%	95.27%
	Grand Total for Trials 1 and 2	47,998.00	48,466.00	99.03%	8,207.00	8,624.00	95.16%	8,380.00	8,624.00	97.17%	98.79%	99.01%	95.38%